TABLE 1.—*Percentage of thunderstorm frequency for the 10-year period 1904–1913*—Continued.

| Stations. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Storms in 10 years. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nantucket, Mass | 2 | 3 | 5 | 9 | 13 | 15 | 21 | 14 | 9 | 5 | 5 | 0 | 223 |
| Narragansett Pier, R. I | 2 | 3 | 5 | 8 | 12 | 16 | 23 | 19 | 9 | 2 | 2 | 0 | 169 |
| Nashville, Tenn | 1 | 3 | 7 | 11 | 12 | 18 | 19 | 15 | 9 | 2 | 3 | 1 | 566 |
| New Haven, Conn | 1 | 2 | 5 | 5 | 14 | 19 | 25 | 18 | 10 | 3 | 1 | 0 | 261 |
| New Orleans, La | 3 | 4 | 5 | 7 | 10 | 15 | 20 | 18 | 14 | 2 | 1 | 3 | 744 |
| New York, N. Y | 1 | 1 | 3 | 9 | 14 | 18 | 25 | 19 | 9 | 3 | 0 | 0 | 284 |
| Norfolk, Va | 0 | 2 | 4 | 8 | 15 | 21 | 22 | 19 | 7 | 2 | 1 | 0 | 406 |
| Northfield, Vt | 0 | 0 | 2 | 3 | 14 | 18 | 31 | 21 | 10 | 3 | 0 | 0 | 242 |
| North Platte, Nebr | 0 | 0 | 2 | 5 | 16 | 23 | 25 | 20 | 8 | 2 | 0 | 0 | 449 |
| Oklahoma, Okla | 0 | 3 | 5 | 12 | 17 | 19 | 14 | 13 | 10 | 5 | 2 | 0 | 448 |
| Omaha, Nebr | 0 | 1 | 3 | 8 | 16 | 20 | 18 | 17 | 12 | 6 | 2 | 0 | 499 |
| Oswego, N. Y | 1 | 2 | 4 | 4 | 14 | 19 | 22 | 18 | 11 | 6 | 1 | 0 | 296 |
| Palestine, Tex | 2 | 4 | 7 | 14 | 14 | 14 | 15 | 11 | 10 | 5 | 2 | 3 | 523 |
| Pensacola, Fla | 2 | 4 | 5 | 6 | 9 | 14 | 20 | 19 | 14 | 3 | 1 | 2 | 814 |
| Philadelphia, Pa | 0 | 3 | 5 | 7 | 15 | 18 | 23 | 19 | 7 | 4 | 1 | 0 | 319 |
| Phoenix, Ariz | 0 | 2 | 3 | 3 | 4 | 4 | 29 | 36 | 11 | 3 | 3 | 1 | 332 |
| Pierre, S. Dak | 0 | 0 | 1 | 4 | 14 | 23 | 26 | 22 | 8 | 3 | 0 | 0 | 359 |
| Pittsburgh, Pa | 2 | 1 | 6 | 8 | 13 | 20 | 22 | 16 | 11 | 3 | 0 | 0 | 431 |
| Port Crescent, Wash | 0 | 0 | 0 | 0 | 8 | 21 | 25 | 21 | 4 | 0 | 4 | 17 | 24 |
| Port Huron, Mich | 1 | 2 | 3 | 8 | 14 | 18 | 19 | 19 | 9 | 5 | 2 | 0 | 325 |
| Portland, Me | 1 | 0 | 4 | 3 | 12 | 19 | 29 | 18 | 11 | 4 | 0 | 0 | 153 |
| Portland, Oreg | 2 | 6 | 4 | 7 | 24 | 9 | 17 | 15 | 7 | 6 | 4 | 0 | 54 |
| Pueblo, Colo | 0 | 0 | 1 | 5 | 14 | 20 | 29 | 22 | 9 | 1 | 0 | 0 | 484 |
| Raleigh, N. C | 1 | 1 | 4 | 6 | 13 | 19 | 25 | 19 | 9 | 2 | 1 | 0 | 469 |
| Rapid City, S. Dak | 0 | 0 | 1 | 3 | 13 | 26 | 28 | 22 | 6 | 2 | 0 | 0 | 359 |
| Red Bluff, Cal | 8 | 4 | 10 | 8 | 25 | 17 | 8 | 2 | 8 | 10 | 0 | 2 | 52 |
| Richmond, Va | 0 | 0 | 4 | 9 | 13 | 20 | 23 | 21 | 8 | 2 | 1 | 0 | 415 |
| Roseburg, Oreg | 0 | 0 | 9 | 6 | 14 | 17 | 20 | 11 | 17 | 3 | 0 | 3 | 35 |
| Sacramento, Cal | 6 | 9 | 26 | 0 | 6 | 9 | 0 | 6 | 21 | 12 | 0 | 3 | 34 |
| St. Louis, Mo | 1 | 2 | 7 | 10 | 13 | 17 | 16 | 17 | 11 | 4 | 3 | 0 | 526 |
| St. Paul, Minn | 0 | 0 | 1 | 4 | 15 | 22 | 19 | 21 | 14 | 3 | 0 | 0 | 328 |
| Salt Lake City, Utah | 3 | 1 | 5 | 7 | 8 | 16 | 20 | 25 | 12 | 4 | 0 | 0 | 356 |
| San Antonio, Tex | 0 | 2 | 6 | 13 | 16 | 10 | 13 | 13 | 15 | 5 | 3 | 3 | 386 |
| San Diego, Cal | 6 | 3 | 11 | 3 | 6 | 6 | 11 | 17 | 9 | 14 | 6 | 9 | 35 |
| San Juan, P. R | 0 | 0 | 1 | 3 | 9 | 13 | 14 | 16 | 20 | 16 | 6 | 2 | 472 |
| Sandusky, Ohio | 2 | 1 | 4 | 6 | 15 | 18 | 21 | 17 | 10 | 4 | 1 | 0 | 400 |
| San Francisco, Cal | 12 | 50 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 13 | 8 |
| Santa Fe, N. Mex | 0 | 1 | 3 | 4 | 9 | 15 | 29 | 24 | 12 | 3 | 0 | 0 | 732 |
| Sault Ste. Marie, Mich | 0 | 0 | 4 | 4 | 9 | 17 | 19 | 19 | 15 | 11 | 3 | 0 | 209 |
| Savannah, Ga | 1 | 3 | 3 | 6 | 11 | 17 | 25 | 20 | 11 | 2 | 0 | 1 | 606 |
| Seattle, Wash | 0 | 3 | 10 | 3 | 10 | 25 | 15 | 14 | 12 | 3 | 2 | 2 | 59 |
| Sioux City, Iowa | 0 | 0 | 1 | 6 | 15 | 21 | 21 | 21 | 11 | 4 | 2 | 0 | 436 |
| Spokane, Wash | 0 | 0 | 0 | 8 | 14 | 25 | 24 | 18 | 10 | 3 | 0 | 0 | 108 |
| Springfield, Ill | 2 | 1 | 8 | 11 | 16 | 17 | 17 | 13 | 9 | 4 | 3 | 0 | 509 |
| Springfield, Mo | 2 | 2 | 5 | 10 | 14 | 19 | 18 | 12 | 10 | 4 | 3 | 1 | 572 |
| Tampa, Fla | 1 | 2 | 3 | 3 | 10 | 17 | 24 | 22 | 14 | 3 | 0 | 1 | 944 |
| Tatoosh Island, Wash | 8 | 6 | 2 | 2 | 2 | 4 | 9 | 6 | 19 | 12 | 14 | 14 | 53 |
| Toledo, Ohio | 2 | 1 | 3 | 8 | 13 | 18 | 23 | 16 | 9 | 4 | 2 | 0 | 403 |
| Topeka, Kans | 1 | 1 | 5 | 7 | 15 | 17 | 18 | 15 | 12 | 6 | 4 | 0 | 512 |
| Vicksburg, Miss | 3 | 5 | 6 | 11 | 11 | 16 | 17 | 15 | 10 | 2 | 2 | 2 | 668 |
| Walla Walla, Wash | 0 | 0 | 1 | 4 | 16 | 28 | 21 | 20 | 11 | 1 | 0 | 0 | 88 |
| Washington, D. C | 1 | 2 | 4 | 8 | 12 | 18 | 25 | 17 | 9 | 2 | 1 | 0 | 392 |
| Wichita, Kans | 0 | 2 | 4 | 9 | 17 | 18 | 18 | 14 | 12 | 5 | 2 | 0 | 531 |
| Williston, N. Dak | 0 | 0 | 0 | 2 | 11 | 29 | 23 | 25 | 9 | 1 | 0 | 0 | 211 |
| Wilmington, N. C | 1 | 3 | 5 | 6 | 11 | 18 | 23 | 21 | 9 | 3 | 1 | 0 | 511 |
| Winnemucca, Nev | 0 | 0 | 4 | 4 | 12 | 23 | 23 | 21 | 11 | 3 | 1 | 0 | 142 |

## STORMS AND HURRICANES IN JAMAICA, 1655–1915.

By MAXWELL HALL.

[Dated: Montego Bay P. O., Jamaica, W. I., Dec. 12, 1915.]

The Government Meteorologist for Jamaica, publishes in his Weather Report No. 449, for November, 1915, a *corrected* list of severe storms and hurricanes that have passed over Jamaica and done more or less damage there between the years 1655 and 1915. In correcting his list he has omitted those which, though represented on some charts as crossing Jamaica, were not felt as severe storms on the island or really missed it completely. The lower limit of wind velocity adopted for qualifying in this list is one of 60 miles an hour, and the storm of June 13, 1904, barely secured a place in the table on this basis; it had unusual interest because of two cyclones visiting the west end of the island. The corrected table is printed below.—C. A., jr.

*Table of storms and hurricanes in Jamaica, 1655 to 1915.*

| Year. | Month. | Description. | Authority; notes. |
|---|---|---|---|
| 1670 | Oct. 7 | Storm; the fleet at Jamaica driven ashore | [Poey: K. Johnstone Phys. Atl., 1856. |
| 1689 | | Storm mentioned in early vols. Jamaica Almanac. | Gardner calls it a hurricane, ed. 1909, p. 73. |
| 1712 | Aug. 28 | First hurricane experienced by English in Jamaica. | [Poey: Gardner, p. 112. |
| 1714 | Aug. 29 | Some men-of-war driven ashore in a storm. | [Poey: K. Johnstone Phys. Atl. |
| **1722** | **Aug. 28** | Great hurricane damaged the whole island; center passed over Port Royal. | Atkins "Voyage to Guinea, Brazil, and the W. I.," 1737, p. 238; Long, v. 2, p. 145. |
| 1726 | Oct. 22 | Hurricane swept east end of island | Long, v. 2, p. 146; Gardner .p. 115. |
| **1744** | **Oct. 20** | Great hurricane damaged whole island; 104 ships wrecked in harbor. | Clowes, 3, p. 275; Long, v. 2, p. 140; Gardner, p. 125. |
| 1751 | Sept. 2 | Storm | Jamaica Almanac. |
| **1780** | **Oct. 3** | Great hurricane destroyed Savannah-la-Mar and damaged whole island. | Wm. Beckford "Descriptive account of the island of Jamaica," 1790. Bryan Edwards, ed. 1819, v. 1. p. 236. Reid, "Law of storms," etc. |
| 1781 | Aug. 1 | Hurricane; 120 vessels wrecked in Kingston Harbor and at Port Royal. | Bryan Edwards, v. 1, p. 234, brief mention. |
| 1784 | July 30 | Hurricane; wrecked all but 4 of vessels at Kingston and Port Royal. | Do. |
| 1785 | Aug. 27 | Storm | Do. |
| 1786 | Oct. 20 | Storm followed by great scarcity of food | Do. |
| **1812** | **Oct. 12–14** | Great hurricane damaged the whole island. | Jamaica mag.; Jam. phys. jour., 1835. |
| 1813 | Aug. 1 | Storm damaged shipping and buildings in Kingston. | Jam. Courant, Aug. 2–9, 181, 1813; Bryan Edwards, v. 5, p. 77. |
| 1813 | Aug. 28 | Storm at Savannah-la-Mar wrecked vessels. | |
| 1815 | Oct. 18, 19 | Hurricane over eastern part of island, and great floods. | Jam. phys. jour., 1835; Bryan Edwards, v. 5, p. 78. |
| | | Great destruction of houses in St. George, St. David, etc. | Jam. wthr. rpt., No. 352, Apr., 1908. |
| 1818 | Nov. 18, 20 | Hurricane swept western part of island | |
| 1832 | Aug. 7 | Violent storm that lasted but 3½ hours | Keith Johnstone, Phys. Atlas. |
| 1837 | Sept. 26, 27 | Storm, probably felt all over the island | Jamaica Despatch; Reid: "Law of storms." |
| 1844 | Oct. 5 | Storm over the western end of the island, Falmouth, Montego Bay, and Black River. | |
| 1874 | Oct. 31 | Hurricane over the eastern half of the island. | |
| | Nov. 2 | Center passed over St. Anns Bay | |
| **1880** | **Aug. 18** | Great hurricane; two cyclones damaged the eastern half of the island. | Jam. wthr. rep., v. 1, Introduction. |
| 1886 | June 27 | Storm, whose center passed rapidly from the east end to Montego Bay. | Jam. wthr. rep., No. 67. |
| 1886 | Aug. 19, 20 | Hurricane, whose center took nearly the same course. | Jam. wthr. rep., No. 69. |
| **1903** | **Aug. 11** | Great hurricane, whose center took nearly the same course. | U. S. Mo. wthr. rev., Sept., 1905; Jam. wthr. rep., v. 4, Introduction. |
| 1904 | June 13 | Storm and heavy rains over west end of island, Montego Bay bridge destroyed. | U. S. Mo. wthr. rev., Aug., 1904; Jam. wthr. rep., v. 4, Introduction. |
| **1912** | **Nov. 18** | Great hurricane; two cyclones devastated the west end of the island. | Jam. wthr. rep., No. 411. |
| 1915 | Aug. 12, 13 | Hurricane destroyed banana fields throughout the island, and damaged all the towns on the northern coast. | Jam. wthr. rep., No. 445. |
| 1915 | Sept. 25, 26 | Storm | Jam. wthr. rep., No. 447. |

*Dates of great hurricanes are in* **bold-face type.**

## THE APPLICATION OF PHYSICAL PRINCIPLES TO PROBLEMS SUGGESTED BY OCEANIC CIRCULATION AND TEMPERATURES.[1]

By GEORGE F. McEWEN.

[Dated: La Jolla, Cal.]

Most of our quantitative knowledge of the great ocean currents depends upon the difference between the true position of a ship and that determined from "dead-reckoning"; and upon observations of floating objects. This work has been supplemented by current meter observations in a few limited regions. Also the distri-

[1] Abstract of a paper presented at the San Francisco joint meeting of the Physical Society and Section B of the A. A. A. S., Aug. 2–7, 1915.
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bution of ocean temperatures, which is intimately connected with the motion of the water, is an important though indirect source of information concerning ocean currents. However, the temperature data have been used only in a qualitative way for this purpose. This paper is a summary of some of the quantitative results I have obtained by attempting to calculate the velocities of both horizontal and vertical currents from the distribution of temperatures.

First, assume that the average flow of the water in any direction is negligible, and the depth exceeds 100 meters. Assume the rate of absorption of radiant heat by the water to be an exponential function of the depth, and the rate of loss to be proportional to this exponential function and to a linear function of the temperature. From the observed relation of the mean annual surface temperature and the annual range of the surface temperature to the latitude and also from the assumption that the amount of radiant energy penetrating the water surface is proportional to the solar radiation incident on a horizontal surface at that time and latitude, the normal temperature can be expressed as a function of the depth, latitude, and time. The constants for this expression have been determined and the temperatures, computed for various positions, depths, and times at which normal values would be expected, agreed well with the observed values.

The influence of a horizontal current was estimated by adding to the differential equation first used a term expressing the rate of gain of heat due to the difference in temperature between the water flowing into an element of volume and that flowing out. By assuming the velocity along stream-lines from various points along the west coast of North America to be proportional to the average wind velocity over them, the temperatures as modified by this surface drift were computed and found to agree well with the observed values. Moreover the relative velocity of the wind and current thus found were in good agreement with those determined in other localities by direct measurement.

The relatively low temperature of the inshore water along the Pacific coast is regarded by many to be the result of the local up-welling of cold bottom water. Assuming a vertical current with a velocity proportional to that of the wind parallel to the coast as required by Ekman's theory of oceanic circulation, serial temperatures corresponding to average monthly values off San Diego, were computed and found to agree well with observations. Also some results computed from salinity observations confirmed the above conclusions regarding the circulation.

The author expects to continue the study of this problem and to publish the methods and results in detail, as soon as possible.

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## ALBERT ADAMS YOUNG, 1836-1916.

The Chief of Bureau is glad of the opportunity to publish the following notice from "Climatological Data for the Indiana Section, December, 1915." as a testimonial of the esteem in which Mr. Young was held by this bureau. Such men are the backbone of our corps of cooperative observers, and it is with sincere regret and a sense of loss that we announce Mr. Young's decease.—C. A., jr.

The Rev. Albert Adams Young, for the last eight years cooperative observer for the Weather Bureau at Winona Lake, Ind., died at his home in that place on Friday, January 7, 1916. He was born in Hanover, N. H., in 1836; graduated from Dartmouth College in 1856; and later entered the ministry, holding pastorates at several places in Wisconsin, Iowa, and Illinois. His grandfather, Ebenezer Adams, was professor of mathematics and physics in Dartmouth College; his father, Ira Young, was professor of astronomy and physics in the same institution; and his brother, Charles Augustus Young, the astronomer, professor of astronomy at Dartmouth, and later at Princeton University. He is survived by his wife, Mary Sewall Young, and his two daughters, Elizabeth A. Young, who is in charge of the department of geography, Winona College, and Anna S. Young, who is head of the department of astronomy and director of the observatory at Mount Holyoke College.

Mr. Young was a deep student in the field of science. His microscope stood always at his desk, and his field glass was often in use. He discovered the double crystallization of quartz, and in the quarries near New Lisbon, Wis., the famous reptile tracks that bear his name. He loved flowers and his garden was one of the beauty spots most attractive to visitors at Winona.

As a boy he helped keep the weather records at Dartmouth College observatory, and his interest in the weather and the various problems of meteorology never waned. He kept a weather record continuously since his college days, and not infrequently he with his records was called into court to testify as to weather conditions. His retirement from the ministry gave him more leisure and he thereafter spent much time in weather study, working out various graphs and averages in connection with some line of original research. In his death the Weather Bureau loses one of its best observers.—*J. H. Armington, Meteorologist and Section Director.*